

MOSES LAKE WETLAND MITIGATION BANK

2003 MONITORING REPORT

Wetland Assessment and Monitoring Program

Monitoring Staff

Jesse Barham

Jodie Beall

Fred Bergdolt

Tony Bush

Paul Dreisbach

Cyndie Prehmus

Tuesday Shean

Bob Thomas

Issued March 2004



**Washington State
Department of Transportation**

Environmental Services Office

Moses Lake Wetland Mitigation Bank 2003 Annual Monitoring Report



For additional information about this report or the WSDOT Wetland Assessment and Monitoring Program, contact:

Washington State Department of Transportation
Environmental Services Office
P. O. Box 47332
6639 Capitol Boulevard South
Tumwater, WA 98504-7732

Fred Bergdolt, Wetland Monitoring Field Coordinator
Phone: 360-570-6645
E-mail: bergdof@wsdot.wa.gov

Table of Contents

Executive Summary	1
Introduction	2
Map 1: Moses Lake Wetland Mitigation Bank Site.....	3
Moses Lake Wetland Mitigation Bank Site, Grant County.....	4
APPENDICES	10
Appendix A	
Moses Lake Wetland Mitigation Bank Success Standards.....	11
Appendix B	
Moses Lake Wetland Mitigation Bank Monitoring Plan.....	18
Appendix C	
Methods.....	23
Appendix D	
Moses Lake Wetland Mitigation Bank Aerial Photographs	25
Glossary of Terms	28
Literature Cited	32

Executive Summary

Success standards in the table below were addressed to gauge site progress and guide site management in 2003.

Success Standards	Requirement Year	2003 Results	Management Activities
70% or less than the original aerial cover of <i>Elaeagnus angustifolia</i> (Russian olive)	2004	91% of the original aerial cover ¹	Removed additional trees
Report cover and area of <i>Schoenoplectus</i> spp. (bulrushes) (formerly <i>Scirpus</i> spp.)	2008	15-20% aerial cover	
≤ 5-6 individual plants of <i>Lythrum salicaria</i> (purple loosestrife)	All years	5% aerial cover	Weed control
Report aerial cover of species of concern	2004	20% aerial cover	Weed control

¹ This value was calculated using aerial photographs of the site from 1998 and 2001. Another aerial photo is scheduled to be taken in 2004. This photograph will be compared to the 1998 photograph to address Year 3 (2004) criteria.

Introduction

Background

Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) routinely evaluates the potential for degradation of critical areas that result from these infrastructure improvements. WSDOT strictly complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state “no net loss” policy for wetlands (Executive Order 89-10). Wetland mitigation banks restore, enhance, create, and preserve functioning wetlands that will be used later as compensatory mitigation for unavoidable wetland impacts associated with authorized development. Banks are often designed to consolidate mitigation for multiple small wetland impacts into one large site.

The Moses Lake Wetland Mitigation Bank (hereafter, the Bank) provides advance mitigation for unavoidable project impacts within the Columbia Basin (Map 1). The Bank site was constructed in 2001. Two transportation projects have used the Bank to date, SR 26, E Southwest to Adam’s County line (0.25 acres) and SR 26 Vantage area to Royal City (0.19 acres). The SR 17 Pioneer Way to Stratford (2.00 acres) project will be using additional credits from the Bank site when it is constructed.

WSDOT is required to monitor the Bank for a 20-year period (2001–2020) to document how well the site is performing in relation to performance objectives and success standards listed in the Moses Lake Wetland Mitigation Bank Instrument (MBI Section III Goals, Objectives and Standards of Success).

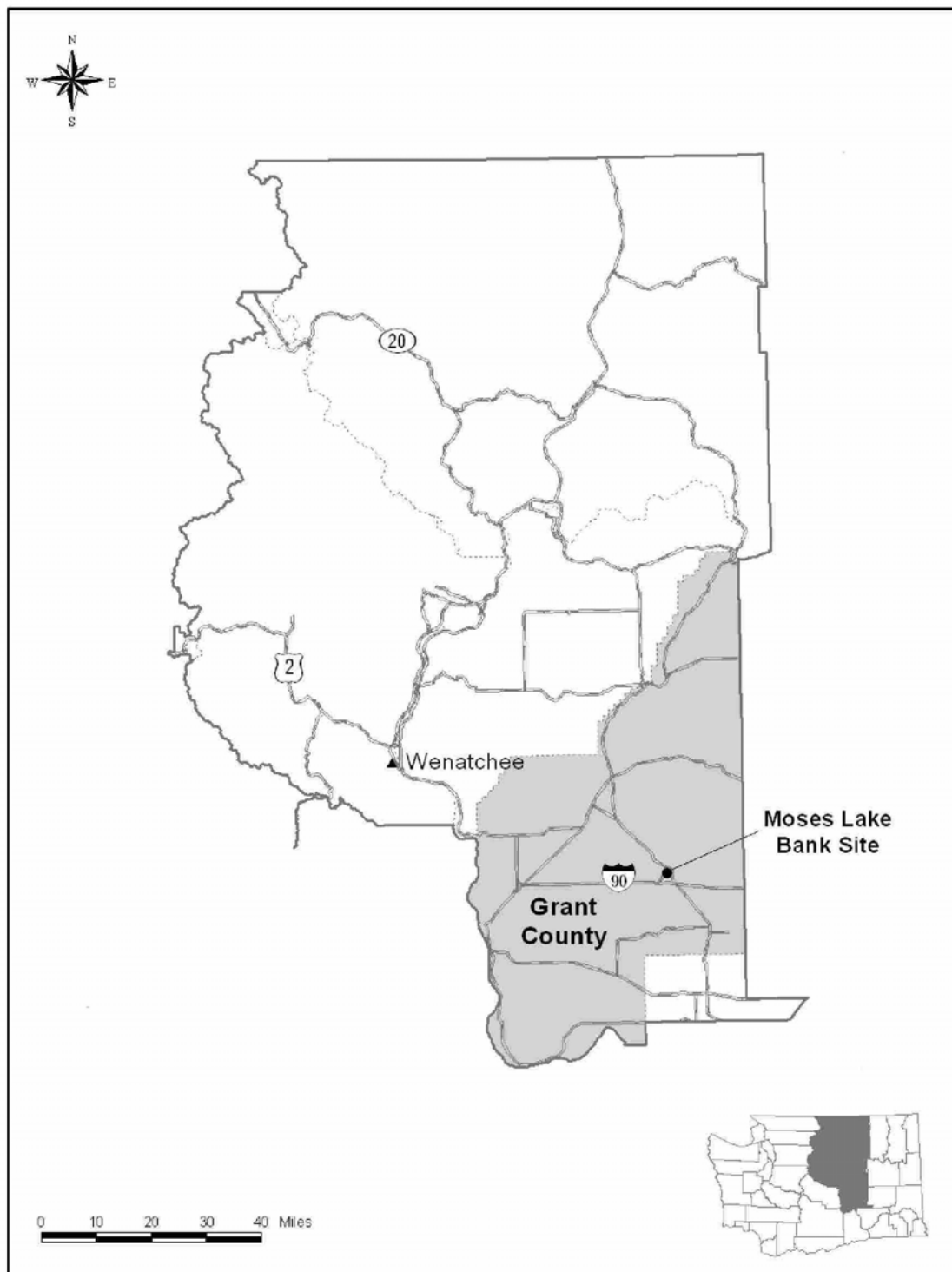
Purpose

The purpose of this document is to report Year 2 (2003) monitoring results for the Bank as required by the MBI. A Year 2 threshold limit for *Lythrum salicaria* (purple loosestrife), and selected success criteria from Years 3 and 7 are addressed herein to help gauge site progress and guide site management. Monitoring activities conducted by the WSDOT Biology Department this year include survival estimates of replanted species, document noxious weeds and weeds of concern, and incidental wildlife observations. Table 1 provides general site information and Table 2 summarizes this year’s monitoring results.

Monitoring reports are issued to regulatory agencies and published on the web at:

www.wsdot.wa.gov/environment/wetmon/default.htm

Map 1: Moses Lake Wetland Mitigation Bank Site



Moses Lake Wetland Mitigation Bank Site, Grant County

Table 1. General Information for the Moses Lake Wetland Mitigation Bank Site

Project Name	Moses Lake Wetland Mitigation Bank
Mitigation Location	At the I/C of S. Division Street and E. 7 th Street, Moses Lake, Grant County
Monitoring Period	2001 to 2020
Year of Monitoring	2 of 20 (Informal Monitoring Year)
Type of Mitigation	Bank
Credit Awarded	5.00 Credits
Credits Used	0.44 Credits
Credits Remaining	4.54 Credits

Table 2. Monitoring and Management Summary for the Moses Lake Wetland Mitigation Bank Site

Success Standards	Requirement Year	2003 Results	Management Activities
70% or less than the original aerial cover of <i>Elaeagnus angustifolia</i> (Russian olive)	2004	91% of the original aerial cover ²	Removed additional trees
Report cover and area of <i>Schoenoplectus</i> spp. (bulrushes) (formerly <i>Scirpus</i> spp.)	2008	15-20% aerial cover	
≤ 5-6 individual plants of <i>Lythrum salicaria</i> (purple loosestrife)	All years	5% aerial cover	Weed control
Report aerial cover of species of concern	2004	20% aerial cover	Weed control

Success Standards

The following success standards for the Bank were excerpted from the *Moses Lake Wetland Mitigation Bank Instrument* (WSDOT 2002). A companion monitoring task from the MBI follows the success standards. Appendix A provides the complete text of the success standards.

Success Standard 1

70% or less of the original aerial cover of Russian olive (2004).

Monitoring Task 1

Each year updated aerial cover of *Elaeagnus angustifolia* (Russian olive) will be documented by visual assessment and recorded on an aerial photo to be included in monitoring reports.

² This value was calculated using aerial photographs of the site from 1998 and 2001. Another aerial photo is scheduled to be taken in 2004. This photograph will be compared to the 1998 photograph to address Year 3 (2004) criteria.

Success Standard 2

Cover and area of *Schoenoplectus* species (bulrushes) (formerly *Scirpus* species) will be estimated and reported (2008).

Monitoring Task 2

Percent cover of *Schoenoplectus* (bulrushes) species will be determined based on ocular estimates and recorded on aerial photos.

Success Standard 3

Purple loosestrife will not exceed pre-construction levels (5-6 individual plants) in any one year (2003).

Monitoring Task 3

Conduct site inventories three times during the *Lythrum salicaria* (purple loosestrife) monitoring period each year. Document the location and extent of infestation (reports of infestations will trigger weed control action within a week of each inventory). Submit results of site inventories and a description of control actions taken in monitoring reports.

Success Standard 4

Report area and cover of non-native and native species of concern (2004).

Monitoring Task 4

Visually estimate area and cover of non-native and/or invasive native species of concern. Document conditions on a site map and submit with monitoring reports.

Methods

A Global Positioning System (Trimble TSCO data logger) was used to survey and map the locations of the current *E. angustifolia* stands (Success Standard 1). The original cover of this species was estimated from aerial photographs.

A vegetation community map and field observations were used to address the aerial cover of *Schoenoplectus* species (Success Standard 2) and the establishment of noxious weeds and weeds of concern, including *L. salicaria* (Success Standards 3 and 4).

Additionally, qualitative observations of woody species survival were made to assess the success of the replanting activities in Fall 2002.

Results and Discussion

Success Standard 1 – 70% of the Original Aerial Cover of Russian Olive

Based on the 1998 pre-construction aerial photograph, the original aerial cover of *E. angustifolia* was estimated to be 111,480 square feet. The aerial cover from a 2001 aerial photo was estimated to be 101,880 square feet (Appendix C). This calculation indicates that *E. angustifolia* has been reduced to 91% of the original aerial cover. Additional trees have been removed since 2001 and an aerial photograph will be taken in 2004 to evaluate compliance with the requirement.

Success Standard 2 – *Schoenoplectus* Species Cover

Schoenoplectus species were installed as plugs during site construction to increase diversity of native plants in the emergent areas. The aerial cover of *Schoenoplectus* species on site in 2003 was qualitatively estimated to be 15-20% cover. The species present on site are *Schoenoplectus acutus* (hardstem bulrush) and *Schoenoplectus americanus* (American bulrush).³ *Schoenoplectus acutus* provides the most cover and is intermixed with *Typha latifolia* (broadleaf cattail) in the wetland area east of the Japanese garden. *Schoenoplectus americanus* provides comparatively less cover and is present around the edges of the wetland. This enhancement effort appears to have succeeded in augmenting the native species composition on site.

Success Standard 3 – Purple Loosestrife Will Not Exceed Pre-Construction Levels

The aerial cover of *L. salicaria* across the entire site was qualitatively estimated to be five percent. This species was concentrated in several areas and individuals were scattered through the rest of the site in August 2003 (Figure 1). This exceeds the threshold of five to six individual plants. Removal of this species is necessary to satisfy the requirement.

Success Standard 4 – Estimate of Area and Cover of Species of Concern

The aerial cover of species of concern, excluding *E. angustifolia*, was qualitatively estimated to be 20 percent. Species of concern include *L. salicaria*, *Iris pseudacorus* (pale yellow iris), and *Cirsium arvense* (Canada thistle). Areas of *I. pseudacorus* are identified on the vegetation community map (Figure 2). *Cirsium arvense* occurs mainly in the drier areas of the site, especially in the southeast corner of the site. Other invasive species that occurred at lower cover levels on site include *Salsola kali* (Russian thistle), *Phalaris arundinacea* (reed canarygrass), *Phragmites australis* (common reed), *Cirsium vulgare* (bull thistle), *Bromus tectorum* (cheatgrass), and *Kochia scoparia* (Mexican fireweed). Weed control is necessary to keep these species from spreading.

³ *Scirpus acutus* and *Scirpus americanus* were recently renamed *Schoenoplectus acutus* and *Schoenoplectus americanus* (USDA 2003).

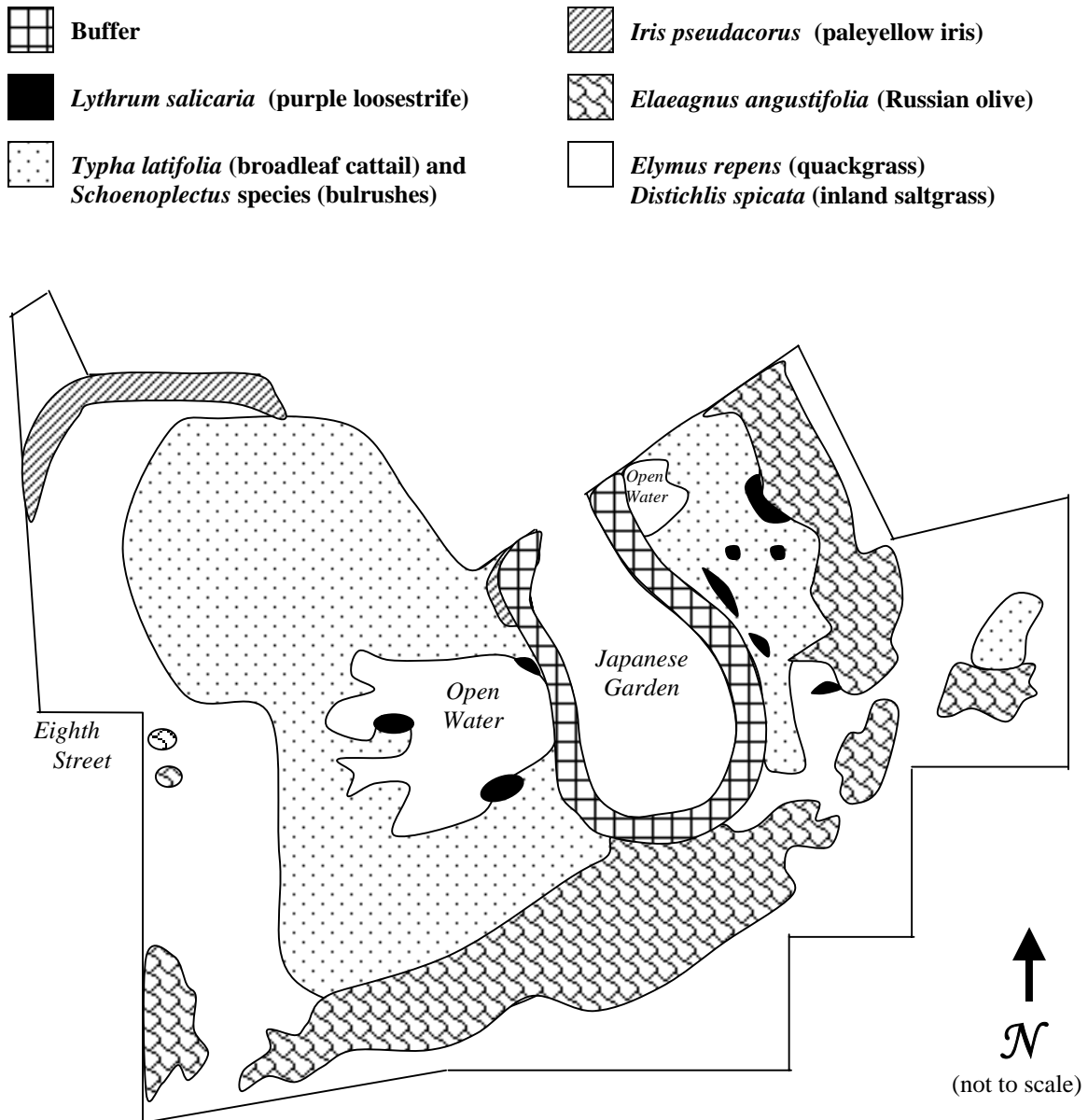


Figure 1. Moses Lake Mitigation Bank Vegetation Community Map (2003)

Incidental wildlife observations during site visits throughout the monitoring period include blacktail deer (*Odocoileus hemionus*), carp (*Cyprinus* species), juvenile fish, and 32 bird species including a juvenile American Goldfinch (*Carduelis tristis*) and juvenile White-crowned Sparrows (*Zonotrichia leucophrys*). Presence of wetland-dependent and wetland-associated species have been documented during site visits. Table 3 provides a summary of the species observed on the site.

Table 3. Moses Lake Wetland Mitigation Bank Birds Observed During Site Visits

Common Name	Scientific Name
Wetland-dependent⁴	
Great Blue Heron	<i>Ardea herodias</i>
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>
Mallard	<i>Anas platyrhynchos</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Belted Kingfisher	<i>Ceryle alcyon</i>
Marsh Wren	<i>Cistothorus palustris</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Wetland-associated	
Killdeer	<i>Charadrius vociferus</i>
Barn Swallow	<i>Hirundo rustica</i>
Yellow Warbler	<i>Dendroica petechia</i>
MacGillivray's Warbler	<i>Oporornis tolmiei</i>
Wetland-independent	
Ring-necked Pheasant	<i>Phasianus colchicus</i>
California Quail	<i>Callipepla californica</i>
Rock Dove	<i>Columba livia</i>
Mourning Dove	<i>Zenaida macroura</i>
Steller's Jay	<i>Cyanocitta stelleri</i>
Black-billed Magpie	<i>Pica pica</i>
American Crow	<i>Corvus brachyrhynchos</i>
American Robin	<i>Turdus migratorius</i>
European Starling	<i>Sturnus vulgaris</i>
Cedar Waxwing	<i>Bombycilla cedrorum</i>
Yellow-rumped Warbler	<i>Dendroica coronata</i>
Western Tanager	<i>Piranga ludoviciana</i>
Song Sparrow	<i>Melospiza melodia</i>
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>
Western Meadowlark	<i>Sturnella neglecta</i>
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>
Cassin's Finch	<i>Carpodacus cassinii</i>
House Finch	<i>Carpodacus mexicanus</i>
American Goldfinch	<i>Carduelis tristis</i>
House Sparrow	<i>Passer domesticus</i>

Survival of Planted Woody Species

Survival was qualitatively assessed to evaluate the success of replanting activities conducted in Fall 2002. Survival was estimated to be 90 percent.

⁴ Birds are assigned an upland or wetland-dependent species status based on the classification scheme presented in Brown and Smith (1998). Regional variation occurs. Additional references used to further classify bird species include Thomas (1979), Ehrlich et al. (1988), and Smith et al. (1997).

Additional Information

The installation of a viewing platform was completed in the Fall 2003. This meets one of the overall project goals which states: educational values of the site will be increased by the proposed restoration and enhancement activities and by development of a trail and the installation of a viewing platform and interpretive sign. Figure 2 is a picture of the completed platform.



Figure 2. Moses Lake Mitigation Bank Site Viewing Platform (Fall 2003)

Management Activities

Two Moses Lake residents have periodically watered the planted woody species. Replanting woody species within the fenced enclosures is planned. Mechanical and chemical weed control is ongoing to control *Cirsium arvense*, *L. salicaria*, and *P. australis*. Other invasive/weed species have been pulled by hand. Weed control is currently focusing on the following species:

- *Cirsium arvense* (Canada thistle)
- *Kochia scoparia* (Mexican fireweed)
- *Lythrum salicaria* (purple loosestrife)
- *Phragmites australis* (common reed)
- *Poa bulbosa* (bulbous bluegrass)

APPENDICES

Appendix A

Moses Lake Wetland Mitigation Bank Success Standards

Success Standards

The following excerpt is from the Moses Lake Wetland Mitigation Bank Instrument (WSDOT 2002). The success standards addressed this year are identified in **bold** font. Other standards will be addressed in the indicated monitoring year.

GOALS, OBJECTIVES AND STANDARDS OF SUCCESS

OVERALL PROJECT GOAL

The goal of the Moses Lake Bank is to restore and enhance wetland functions and values to benefit wildlife resources. Wildlife habitat improvements are the primary wetland functions targeted by the restoration and enhancement work at the Bank Site. A secondary goal is to provide opportunities for public education. The project will restore 0.50 acres of open water wetland, enhance 0.79 acres of open water wetland and 0.15 acres of emergent wetland, enhance and preserve 3.25 acres of the exterior buffer that is comprised of wetland, preserve 5.96 acres of wetland, and designate 0.65 acres to buffer establishment. Educational values of the site will be increased by the proposed restoration and enhancement activities and by development of a trail and the installation of a viewing platform and interpretive sign.

PERFORMANCE OBJECTIVES AND SUCCESS STANDARDS

A subset of the goals listed above are identified as performance objectives for the project that will be used to evaluate and gauge success in achieving the overall goals. Success standards for this project reflect the following specific criteria based on the location of the bank and the WSDOT CBMOA:

- Success standards selected for vegetation reflect growth rates in the Columbia Basin area of eastern Washington (vegetation growth rates for eastern Washington are much slower than what can be expected for western Washington), and
- Success standards are written to be fully achievable (and eligible for full credit release) by the end of 5 years with approval from the BOC.
- Management standards have been developed to guide long-term maintenance and management of the site. These can be found in section 5.4 of the MBI.

The following performance objectives and standards provide criteria against which site success will be measured. Figures 6, 7 and 8 contain Plan Sheets as a reference for site specific details of the performance objectives and success standards.

Performance Objective 1: Water/vegetation interspersed of the wetland area will increase to improve wildlife habitat.

Success Standards	Monitoring Methods
1A. Linear feet of shoreline edge will increase from 200 feet to 1,300 linear feet by the end of Year 1.	Linear feet of shoreline will be measured from current aerial photography of the bank site.
1B. As Built plans documenting the excavation work and documentation of the length of the pre-construction shoreline edge will be submitted to the BOC prior to credit release.	Linear feet of shoreline before and after construction will be determined and indicated on copies of aerial photos. Copies of the aerial photos will be submitted as part of the As Built plans required for credit release.

Contingency Measures: Additional minor excavation and/or grading may be necessary to correct design deficiencies. The BOC will be consulted to determine additional measures if needed.

Performance Objective 2: Native shrub species will dominate the buffer zone established between the bank site and Japanese Garden. This area is intended to provide a natural vegetated screen between the wetland and garden area. It will also provide shade, forage, cover, and nesting areas for wildlife and reduce sedimentation and provide shoreline stabilization.

Success Standards	Monitoring Methods
2A. 60% survival or greater of planted material at Year 1.	A total census of woody plantings will be used to determine survival of plantings in Year 1.
2B. 15% or > aerial cover after Year 3 2C. 30% or > aerial cover after Year 5 2D. 45% or > aerial cover after Year 7 * 2E. 60% or > aerial cover after Year 10 *	Aerial cover of woody species in the buffer zone will be calculated using temporary, random transects and line or point intercept methods.

* Note: Years 7 and 10 are not tied to credit release.

Adaptive Management: Shrub establishment and survival will be monitored closely during the first year after planting. Dead shrubs will be replaced if mortality rates rise above 40 percent. Browse damage by beaver, deer or other wildlife species will be evaluated and protective measures taken to prevent further damage. Fencing may be used to protect plantings if browse damage continues to be a problem. If adaptive management actions do not allow attainment of success standard then contingency actions will be initiated.

Contingency Measures: Evaluate potential causes for poor vegetation establishment; rectify site conditions and/or plant additional vegetation. WDFW staff will be consulted to discuss ways to reduce browse damage by wildlife. Actions may include removing or reducing the numbers of beaver at the site as a temporary measure. The BOC will be consulted if plant materials continue to fail and are not meeting specified success standards.

Performance Objective 3: The cover of Russian olive at the site will be reduced to enhance establishment of native species. A 1998 aerial photo of the site provides the baseline of the cover of Russian olive trees prior to construction. Updated aerial photography will be used to document changes in Russian olive cover over time. The long-term goal for management of the site is to achieve no more than 55 percent of the original (pre-construction 1,259 square feet) aerial cover of Russian olive. Russian olive seedlings will be controlled as part of long-term site management.

Success Standards		Monitoring Methods
3A. Year 0	Establish baseline area occupied by Russian olive.	Baseline (pre-construction) area covered by Russian olive will be outlined on an Aerial Photo, quantified, and submitted in As Builts. Each year updated aerial cover of Russian olive will be documented by visual assessment and recorded on an aerial photo to be included in monitoring reports.
3B. Year 1	85% or < original aerial cover of Russian olive.	
3C. Year 3	70% or < original aerial cover	
3D. Year 5	55% or < original aerial cover	
3E. Year 7	55% or < original aerial cover	
3F. Year 10	55% or < original aerial cover	

* Note: Years 7 and 10 are not tied to credit release.

Adaptive Management: Observations of first round tree removal will help guide subsequent tree removal efforts.

Contingency Measures: Reevaluate Russian olive removal strategies and discuss habitat needs/options with WDFW and the BOC.

Performance Objective 4: Native tree species will be planted within fenced enclosures in areas formerly occupied by Russian olive within the wetland.

Success Standards		Monitoring Methods
4A. Year 0	Construct enclosures and install plantings.	As Built plans will be submitted documenting the number, location, and sizes of enclosures and the number and species of plantings.
4B. Year 1	80% survival of plantings	Trees planted in each enclosure will be counted to determine survival.
4C. Year 3	35% or > aerial cover of native trees per enclosure	Aerial cover of native woody species in fenced enclosures will be calculated using temporary, random transects and line or point intercept methods.
4D. Year 5	50% or > aerial cover of native trees per enclosure	
4E. Year 7	50% or > aerial cover of native trees per enclosure	
4F. Year 10	50% or > aerial cover of native trees per enclosure	

*Note: Year 7 and 10 standards are not tied to credit release.

Adaptive Management: Tree survival will be assessed at frequent intervals during formal and informal site monitoring. The effectiveness of the fenced enclosures to reduce herbivory by deer and beaver will be closely monitored. Damaged fencing will be replaced and/or modified to increase effectiveness.

Contingency Measures: Evaluate potential causes for poor vegetation establishment; rectify site conditions, and/or plant additional vegetation. WDFW staff will be consulted to evaluate damage and/or mortality to trees from deer, beaver or other species of wildlife. The BOC will be contacted to discuss further options if plant materials continue to fail.

Performance Objective 5: The emergent planting zones of the wetland enhancement area will be dominated by native plant species. Plugs of *Scirpus* spp. will be planted along shallow edges of open water to increase native vegetation diversity.

Success Standards		Monitoring Methods
5A. Year 0	Establish areas of emergent vegetation (<i>Scirpus</i> spp.) along edges of open water wetland. Plants will be installed on 4-foot centers.	Submit As Built plans showing area of emergent planting zone and location of plantings.
5B. Year 7	Cover and area of <i>Scirpus</i> spp. will be estimated and reported.	Percent cover of <i>Scirpus</i> spp. will be determined based on ocular estimates and recorded on aerial photos.
5C. Year 10	Cover and area of <i>Scirpus</i> spp. will be estimated and reported.	

Performance Objective 6: Purple loosestrife control will meet or exceed Grant County Noxious Weed Control Board requirements. Purple loosestrife will be controlled anytime encountered on the site. Total eradication is not likely given the historic distribution in the area and likely levels of seed in the soil at the site. If uncontrolled, purple loosestrife could threaten the native species diversity and wildlife habitat functions at the site. Baseline levels consisted of five to six individual flowering plants scattered throughout the cattails. In 2000, the Grant County Weed Board released purple loosestrife bio-control agents into the wetland located directly west of the bank site to reduce a large infestation. This action successfully reduced the purple loosestrife infestation and the bio-control agents have likely been active at the Three-ponds Wetland.

Success Standards		Monitoring Method
6A. Year 0	Determine base line levels of purple loosestrife	Document base line infestation levels of purple loosestrife and indicate locations on map. Submit with As Built Plans.
6B. Years 1-10	Purple loosestrife will not exceed pre-construction levels (5 to 6 individual plants) in any one year.	Conduct site inventories three times during the loosestrife monitoring period each year. Document the location and extent of infestation (Reports of infestations will trigger weed control action within a week of each inventory). Submit results of site inventories and a description of control actions taken in monitoring reports.

Adaptive Management: The locations and numbers of purple loosestrife plants shall be closely tracked. If purple loosestrife exceeds success standard threshold levels, WSDOT will consult with the Grant County Weed Board to increase hand control efforts or to release bio-control agents into the area.

Contingency Measures: If purple loosestrife continues to be a problem WSDOT will discuss with the BOC and Grant County Weed Board. Options may include increased hand control efforts and consideration of chemical control.

Performance Objective 7: Open spaces within the 50-foot exterior buffer will be planted with native woody vegetation to increase the diversity of tree and shrub species. The buffer will provide habitat, visual screening and discourage pedestrian and vehicular access into the site. Habitat structures such brush piles will be added to this area to include a minimum of three structures.

Success Standards		Monitoring Methods
7A. Year 0	As Built plans will document locations of plantings and habitat structures.	Visually observe and document locations of plantings and habitat structures on As Built plan sheets.
7B. Year 5	There will be 20 or more living native woody plants per acre consisting of at least three separate native woody species.	Inventories and direct counts will be used to document the number and species of native woody plants per acre.

Adaptive Management: Native tree and shrub plantings will be closely monitored during the first year plant establishment period to assess survival rates and/or browse damage by deer, beaver or other species of wildlife. Steps will be taken to reduce damage of planted material by replacing plant materials and/or increasing the level of protection of damaged planted materials throughout the monitoring period.

Contingency Measures: Evaluate potential causes for poor vegetation establishment; rectify site conditions, and/or plant additional vegetation. WDFW staff will be consulted to evaluate damage and/or mortality to tree and shrubs from deer, beaver or other species of wildlife. WSDOT will consult the City of Moses Lake if unauthorized pedestrian or vehicular access becomes a problem or cannot be controlled by existing means. Increasing the number of signs, surveillance measures, and replacing fencing, may be used to enhance site protection. The BOC will be contacted if unauthorized access cannot be controlled.

Performance Objective 8: State and local listed noxious weeds will be controlled to meet requirements of the Grant County Noxious Weed Control Board. Grant County adopts a noxious weed list each year categorizing weeds into three categories (A, B and C). Based on this list, landowners are required by law to: Eradicate all class A noxious weeds; Control and prevent the spread of all class B noxious weeds designated for control in that region within and from the owner's property; and Control and prevent the spread of all class B and class C noxious weeds listed on the county weed list as locally mandated

control priorities within and from the owner's property (RCW 17.10.140). Only Class B and C weeds exist on site at this time. In addition to purple loosestrife (objective 6), species of concern include, but are not limited to Canada thistle (*Cirsium arvense*), Kochia (*Kochia scoparia*), and Common reed (*Phragmites communis*).

Success Standards		Monitoring Methods
8A. Year 1	Report area and cover of non-native and native species of concern.	Visually estimate area and cover of non-native and/or invasive native species of concern. Document conditions on a site map and submit with monitoring reports.
8B. Years 3&5	Report area and cover of non-native and native species of concern.	Visually estimate area and cover of non-native and/or invasive native species of concern. Document conditions on a site map and submit with monitoring reports.

Adaptive Management: Weed control efforts will focus on controlling existing infestations and preventing establishment of new ones. Funds are set aside for weed control and other site maintenance activities.

3.3 CONTINGENCY MEASURES AND REMEDIAL ACTIONS

Monitoring will be used to gauge the success of the bank site. Annual monitoring reports will document achievement or non-attainment of success standards and any remedial actions taken. Each success standard contains an adaptive management and contingency component that will be used if, and when, a portion of the site is not meeting a success standard. In the event that one or more components of the bank do not achieve success standards or comply with any other requirements of this MBI, the following actions will be taken:

1. Upon discovering that a component of the bank does not comply with the requirements of this MBI, WSDOT shall take all appropriate actions to bring that component into compliance as soon as practicable.
2. If remedial actions taken by WSDOT do not bring that component of the bank into compliance with the requirements of this MBI despite reasonable efforts being made by WSDOT, WSDOT may elect to take the following actions:
 - a. Submit to the signatory agencies a proposal to modify the MBI (e.g., shift from one type of vegetation to another). Any modification to the MBI shall require the approval of the signatory agencies.
 - b. Provide written notice of WSDOT's intent to discontinue efforts to achieve the standards of success for that component of the bank. Upon providing such notice, no credits may be established for that component, but WSDOT shall be released from future maintenance and monitoring obligations for that component provided that releasing WSDOT from those obligations does not

adversely affect the remainder of the bank. Any unused previously established credits for that component shall be removed from the bank. Any used previously established credits for that component shall be replaced with other unused established credits in the bank. If there are insufficient unused credits to replace those removed credits, WSDOT shall implement other appropriate compensatory mitigation approved by the appropriate permitting agencies.

Appendix B

Moses Lake Wetland Mitigation Bank Monitoring Plan

Introduction

The Moses Lake Wetland Mitigation Bank provides advance compensatory mitigation for unavoidable impacts to wetlands from proposed highway construction projects within the Columbia Basin. The Washington Department of Transportation (WSDOT) is required to monitor the Moses Lake Wetland Mitigation Bank to document how well the site is performing in relation to performance objectives and success standards listed in the Moses Lake Wetland Mitigation Bank Instrument (MBI Section III Goals, Objectives and Standards of Success).

WSDOT Wetland Mitigation Monitoring Program

WSDOT's Wetland Mitigation Monitoring Program staff will conduct the monitoring at the bank site. The Monitoring Program conducts compliance monitoring of all of WSDOT's compensatory wetland mitigation projects. Compliance monitoring provides a means for tracking the development of WSDOT mitigation projects over time, and for determining compliance with permits issued by federal, state, local, or tribal jurisdictions. The Monitoring Program also provides an important internal feedback role in mitigation site management and maintenance that serves as an essential link in the internal adaptive management process, which increases the overall success of mitigation sites.

Copies of recent annual monitoring reports for WSDOT wetland mitigation projects are available on WSDOT's web page (<http://www.wsdot.wa.gov/environment/eao/wetmon/default.htm>) (updated).

Monitoring Protocols used by WSDOT

WSDOT's Monitoring Program uses a variety of monitoring methods. Quantitative data collection techniques are based on standard ecological and biostatistical methods including those described in the following references:

- Bonham, C.D. 1989. *Measurements for Terrestrial Vegetation*. John Wiley & Sons, New York, NY.
- Coulloudon, B., K. Eshelman, J. Gianola, N. Habich, L. Hughes, C. Johnson, M. Pellant, P. Podborny, A. Rasmussen, B. Robles, P. Shaver, J. Spehar, J. Willoughby. 1999. *Sampling Vegetation Attributes*. Bureau of Land Management Technical Reference 1734-4, Denver, CO.
- Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. *Measuring and Monitoring Plant Populations*. Bureau of Land Management Technical Reference 1730-1, BLM/RS/ST-98/005+1730, Denver, CO.
- Krebs, C.J. 1999. *Ecological Methodology*, 2nd edition. Benjamin/Cummings, New York, NY.

- Horner, R.R. and K.J. Raedeke. 1989. *Guide for Wetland Mitigation Monitoring Operational Draft*. Prepared for Washington State Transportation Commission, Department of Transportation, Olympia, WA. WA-RD 195.1.
- Zar, J.H. 1999. *Biostatistical Analysis*, 4th edition. Prentice-Hall, Inc., Upper Saddle River, NJ.

The configuration, placement, and number of sample units (e.g., plots, lines, point-lines, point frames) required to address site-specific performance objectives will be based on characteristics observed within the vegetative community and patterns of plant distribution. Sample size analysis will be used to ensure data from an adequate number of sample units has been obtained to meet the monitoring objectives. The monitoring report will include a complete description of the methods and sampling designs used to monitor the bank site.

Submission of Annual Reports

WSDOT will prepare and submit annual monitoring reports to signatory agencies by March 31st of each year. The reports will address progress toward meeting the success standards specified in the MBI and the results of any adaptive management actions taken to correct deficiencies that occurred in meeting these standards.

Performance Objectives

Performance objectives outlined in the MBI are intended to gauge the success of the site in meeting the overall project goal. The goal of the Moses Lake Wetland Mitigation Bank is to restore and enhance wetland functions and values to benefit wildlife and provide opportunities for public education and interpretation about wetlands. Wildlife habitat improvements are the primary wetland functions targeted by the restoration and enhancement work at the bank site. Wildlife viewing opportunities and educational values of the site will be increased by the proposed restoration and enhancement activities and by the installation of a viewing platform and interpretive sign.

Monitoring Schedule

The Moses Lake Bank site will be formally monitored over a ten-year period. Informal monitoring will occur for an additional 10 years (for a total of 20 years) to document changes in the site over time and provide information to the City of Moses Lake to guide long-term site management. Formal site monitoring will occur between June and September. Informal monitoring will occur throughout the year. It should be noted that more frequent monitoring might be recommended because of specific site conditions or site-specific goals. For example, more frequent monitoring may be needed if the cover of invasive weeds is unusually high or important results of a management treatment are needed. The bank site will be monitored annually according to the schedule listed below:

Monitoring Year	Tasks	Expected Date
Year 0	Conduct Verification Inspection. Establish baseline area occupied by Russian olive, determine length of shoreline edge before and after construction and document conditions on copies of aerial photos. Document plant installation, location of habitat features, location and extent of Purple Loosestrife/Russian olive populations, and post-construction shoreline edge on As Builts.	Once upon completion site construction/plant installation (2001)
Year 1	Conduct first-year plant inspection. Determine length of shoreline edge, aerial cover of Russian olive population, and document conditions on current aerial photography, and calculate differences from previous year. Document location and extent of noxious weed populations and implement control. Record wildlife use observed. Complete Monitoring Report.	Quarterly site visits (2002)
Year 2	Conduct informal monitoring. Complete Monitoring Report.	Quarterly site visits (2003)
Year 3	Determine aerial cover of native woody plant species in the buffer and enclosures. Determine aerial cover of Russian olive population, document conditions on current aerial photography, and calculate differences from previous year. Document location and extent of noxious weed populations and implement control. Record wildlife use observed. Complete Monitoring Report.	Quarterly site visits (2004)
Year 4	Conduct informal monitoring. Complete Monitoring Report.	Quarterly site visits (2005)
Year 5	Determine aerial cover of native woody plant species in the buffer and enclosures. Determine native woody plants per acre in the exterior buffer. Determine aerial cover of Russian olive population, document conditions on current aerial photography, and calculate differences from previous year. Document location and extent of noxious weed populations and implement control. Record wildlife use observed. Complete Monitoring Report.	Quarterly site visits (2006)
Year 7	Determine aerial cover of native woody plant species in the buffer and enclosures. Estimate aerial cover of <i>Scirpus</i> spp. and record conditions on aerial photography. Determine aerial cover of Russian olive population, and document conditions on current aerial photography, and calculate differences from previous year. Document location and extent of noxious weed populations and implement control. Record wildlife use observed. Complete Monitoring Report.	Annual site visit (2007)
Year 10	Determine aerial cover of native plant species in the buffer and enclosures. Estimate percent cover of <i>Scirpus</i> spp. and record conditions on aerial photography. Determine aerial cover of Russian olive population, document conditions on current aerial photography, and calculate differences from previous year. Document location and extent of noxious weed populations and implement control. Record wildlife use observed. Complete Monitoring Report.	Annual site visit (2008)
Year 11-20	Conduct informal monitoring. Complete Annual Monitoring Reports.	Annual site visits (2009-2018)

Monitoring Methodology

Verification inspection

Provide documentation of plant installation to include existing conditions approximately 2 months after planting activities are complete to include only those plants that survived transplant shock. Include information on the location, species and count of all installed plant species on As-Built plans.

First-year plant inspection

A total count of all installed trees and shrubs will be conducted one year after installation. This first year monitoring will serve as the one-year plant establishment period.

Determine aerial cover of native woody plant species in the buffer and enclosures

Calculate percent aerial cover of native woody species in the buffer zone and fenced enclosures of the wetland enhancement area. Aerial cover will be quantified along random transects using line or point intercept methods. To ensure effective interspersions of sample units (points or lines) across the buffer and wetland enhancement zones, sample units will be located along transects using simple, stratified, systematic, or restricted random sampling methods. The location and method of each sampling area will be identified in monitoring reports.

Determine native woody plants per acre in the exterior buffer

Inventories and direct counts will be used to determine native woody plant species in the exterior buffer. The number of different species that are included in the inventory will be documented.

*Estimate aerial cover of *Scirpus* spp. and record conditions on aerial photography*

Percent aerial cover of *Scirpus* spp. within emergent planting zones of the wetland enhancement area will be determined based on ocular estimates. Results will be recorded on aerial photography and submitted with monitoring reports during Years 7 and 10.

Establish baseline area/determine aerial cover of Russian olive population, document conditions on current aerial photography

A 1998 aerial photo of the site will be used to determine the baseline conditions of Russian olive coverage. Subsequent years will utilize current photos to calculate aerial cover of Russian olive populations. Both updated aerial photos and changes in Russian olive populations will be included in all monitoring reports.

Determine length of shoreline edge, document conditions on current aerial photography

The linear feet of shoreline along the open-water wetland will be determined before and after construction of the site and indicated on copies of aerial photos. All measurements will be made using a delineation of the shoreline edge based on current aerial photography. Both updated aerial photos and documentation of shoreline variation will be included in all monitoring reports.

Document noxious weed populations.

Base line infestation levels of purple loosestrife will be indicated on As-Built Plans. Each year, the location and extent of purple loosestrife infestation will be documented and included in annual monitoring reports. If Purple loosestrife is encountered, control methods will be implemented. Purple loosestrife control will meet or exceed Grant County Noxious Weed Board requirements.

Wildlife observations

Wildlife observations will be recorded during formal site monitoring in the summer (June-September). All species observed on site will be recorded, including birds flying overhead. Signs of wildlife use, including scat and fur, will also be recorded.

Informal monitoring

In contrast to quantitative sampling during formal monitoring, a general visual review of the mitigation area will be conducted to determine the effectiveness of the mitigation.

Complete monitoring report

Monitoring reports will provide a description of site conditions observed during the past year. Reports will also include a discussion of site conditions as they relate to performance objectives as stated in MBI. Current aerial photography will be included in monitoring reports except during informal monitoring years. Results of monitoring will lead to recommendations for maintenance and contingency activities to ensure performance objectives and mitigation goals are met. The monitoring report will describe adaptive management procedures necessary to achieve the greatest success for meeting performance objectives by the end of the monitoring period.

Appendix C

Methods

Methods used for monitoring wetland mitigation bank sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.⁵ The Wetland Program's current monitoring methods include the following key elements:

Objective-based Monitoring

We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process includes four iterative steps:

1. success standards are developed to describe the desired condition,
2. management action is carried out to meet the success standard,
3. the response of the resource is monitored to determine if the success standard has been met, and
4. management is adapted if the standards are not achieved.

Monitoring is integral to the success of an effective adaptive management strategy. Without valid monitoring data, management actions may or may not result in improved conditions or compliance with regulatory permits. Timely decisions, based on valid monitoring data, result in increased efficiency and higher probabilities of success (Shabman 1995; Thom and Wellman 1996). The adaptive management process is illustrated in Figure 3.

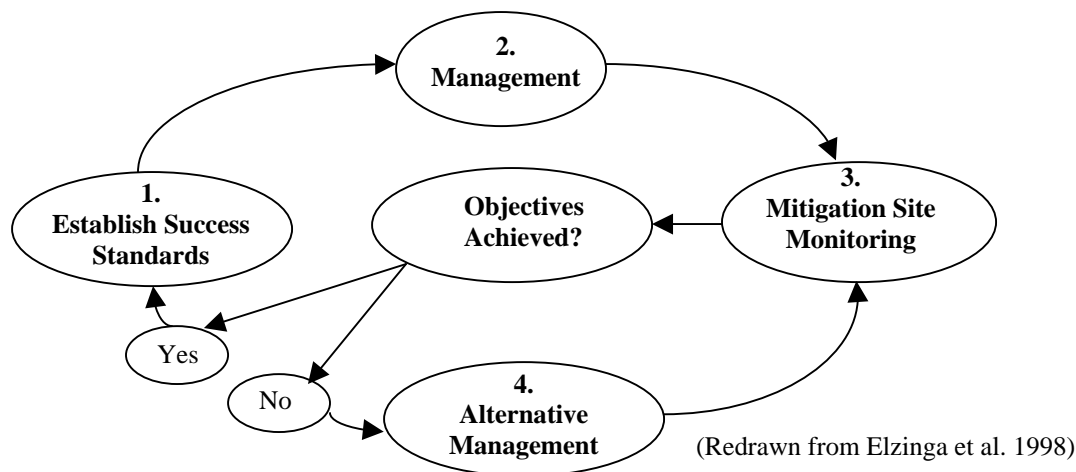


Figure 3. The Adaptive Management Process

⁵These methods are based on techniques described in Bonham (1989), Elzinga et al. (1998), Krebs (1999), Zar (1999), and other sources.

Statistical Rigor

WSDOT's monitoring approach strives to minimize subjectivity in data collection and increase the reliability of data collection and analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

Success Standards

Site objectives and success standards are important elements of an MBI. They indicate the desired state or condition of a wetland mitigation bank site at a given point in time. The MBI also provides contingencies in case a specific undesirable condition occurs. Contingencies typically initiate a management response at the onset of a particular condition, for example, excessive cover by invasive species or insufficient cover by trees and shrubs.

Wetland Assessment and Monitoring Program staff thoroughly examine goals, objectives, and success standards to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in a success standard, clarification is sought from region staff.

For compliance purposes, aerial cover calculations include only areas covered by vascular plants (including floating-leaved species). Areas covered by thallophytes (algae, fungi, bacteria), bryophytes (mosses and liverworts), structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, common names, and nativity used in this report were obtained from the *PLANTS Database* (USDA 2003).

Hydrophytic plant indicator status was obtained from the *National List of Plant Species that Occur in Wetlands: Northwest* (Reed 1988 and 1993). Where invasive or noxious weeds are addressed, county specific listings in the *State Noxious Weed List* are referenced (Washington State Noxious Weed Control Board 2003).⁶

Wildlife Monitoring

Incidental wildlife observations are recorded during all site visits.

Hydrology Monitoring

Primary and secondary field indicators of wetland hydrology (ECY 1997) are recorded to address hydrology and to aid in future delineation efforts.

⁶ In some cases, other nuisance species may be included in invasive cover estimates.

Appendix D

Moses Lake Wetland Mitigation Bank Aerial Photographs

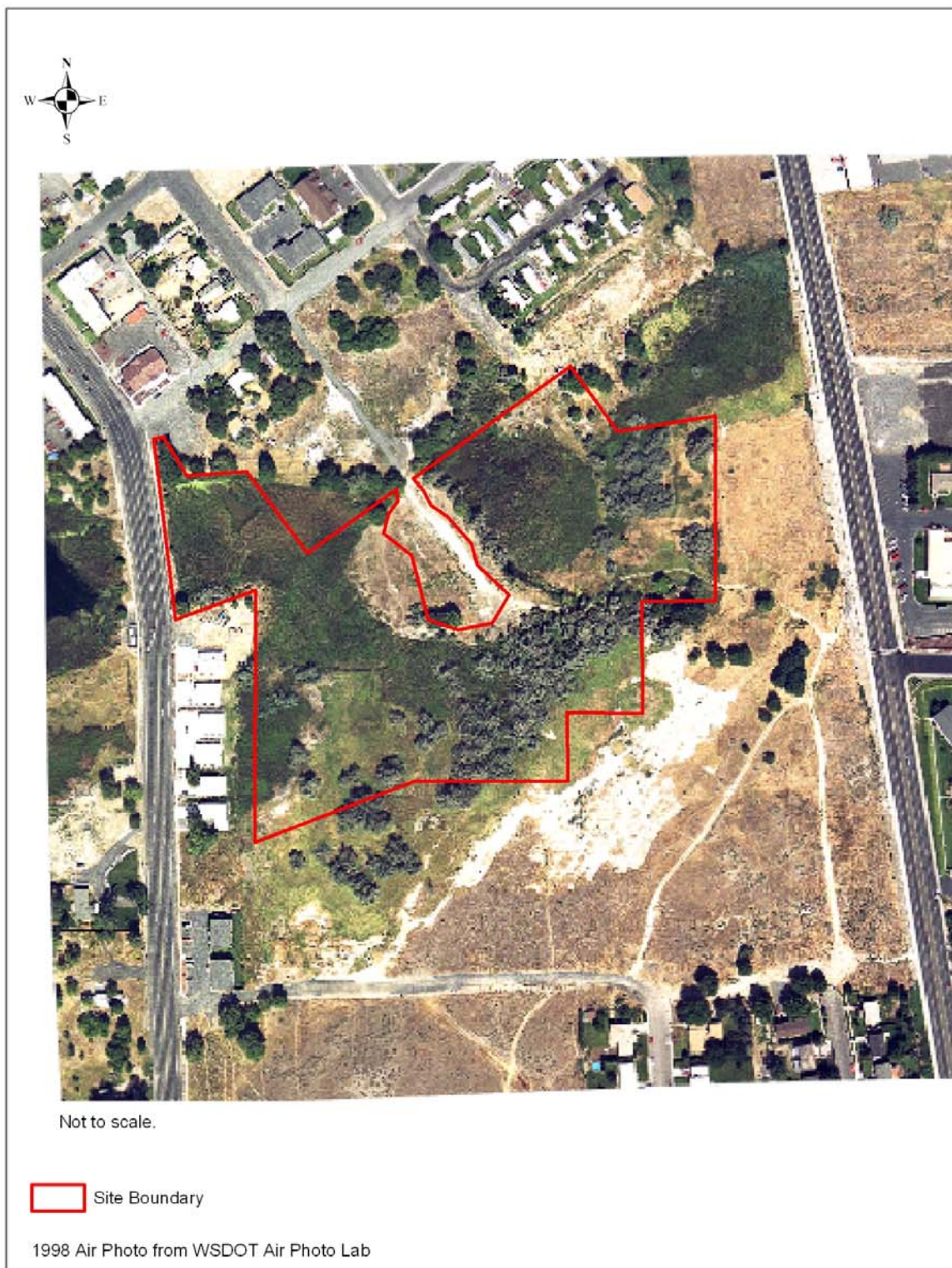


Figure 4. Moses Lake Wetland Mitigation Bank in 1998



Figure 5. Moses Lake Wetland Mitigation Bank in 2001

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the percent of ground surface covered by vegetation of a particular species (or suite of species) when viewed from above (Elzinga et al. 1998). Values for aerial cover are typically obtained from point-line, point-frame, or line-intercept data.

Areal estimates – are made using the known boundary of a feature or biological population. Areal estimates are often expressed in units of area.

Aquatic vegetation – includes submerged and rooted (*Elodea*, *Myriophyllum*) or floating (non-rooted) plants (*Lemna*, *Azolla*, *Wolffia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar*, *Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Canopy cover – the coverage of foliage canopy (herbaceous or woody species) per unit ground area.

Community – a group of populations of species living together in a given place and time.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width.

Cryptogam – any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of plants per unit area (typically square meters).

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) tube that includes a horizontal and vertical leveling device and a mirror to locate a precise vertical point in space either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.

Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – a plant that interferes with management objectives on a specific site at a specific point in time (Whitson et al. 2001). For monitoring purposes, invasive species include those listed on the current County Noxious Weed List, and on a site-by-site basis, other species may be included (such as *Rubus armeniacus* (Himalayan blackberry)).

Line-segment – a linear sample unit that is used to measure vegetative cover.

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats, line-segments or point-lines (Elzinga et al. 1998).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point-frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point-intercept device – a tripod that supports a rod that can be leveled and lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point-quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which inferences are made.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance (birds) – the number of individuals per unit of sampling effort.

Restricted random sampling method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives provide a complement to success standards and describe the desired level of precision for sampling. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than six meters (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified random sampling method – the population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic random sampling method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – for vegetation surveys, the transect is a line used to assist in the location sample units (point-lines, quadrats, line-segments or frames) across the monitoring study area.

Tree – a woody plant that at maturity is usually six meters (20 feet) or more in height and generally has a single trunk, unbranched for one meter or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

Wetland-dependent species (birds) – restricted in temporal or spatial distribution to wetlands based on an intrinsic feature or features of the environment (Finch 1989).

Literature Cited

1. Bonham, C. D. 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons, New York, NY.
2. Brown, S. C. and C. R. Smith. 1998. Breeding Season Bird Use of Recently Restored Versus Natural Wetlands in New York. *Journal of Wildlife Management*. 62(4):1480-1491.
3. Cooke, S. S., (ed.). 1997. A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon. Seattle Audubon Society, Seattle, WA.
4. Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of The United States. United States Department of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C.
5. Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The Birder's Handbook. Simon and Schuster, Inc., NY.
6. Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Bureau of Land Management Technical Reference 1730-1, BLM/RS/ST-98/005+1730. National Business Center, Denver, CO.
7. Executive Order 89-10. WSR 90-01-050. Protection of Wetlands. December 11, 1989.
8. Finch, D. M. 1989. Habitat Use and Habitat Overlap of Riparian Birds in Three Elevational Zones. *Ecology* 70 (4): 866-880.
9. Hruby, T., T. Granger, and E. Teachout. 1999. Methods for Assessing Wetland Functions. Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington. Part 2: Procedures for Collecting Data. Washington State Department of Ecology Publication #99-116, Olympia, WA.
10. Krebs, C. J. 1999. *Ecological Methodology*, 2nd edition. Benjamin/Cummings, New York, NY.
11. Reed, P. B. 1988. National List of Plant Species that Occur in Wetlands: Northwest (Region 9). United States Department of the Interior. Fish and Wildlife Service. Biological Report 88 (26.9).
12. Reed, P. B. 1993. Supplement to the National List of Plant Species that Occur in Wetlands: Northwest (Region 9). United States Department of the Interior. Fish and Wildlife Service. Supplement to Biological Report 88 (26.9).

13. Shabman, L. A. 1995. Making Watershed Restoration Happen: What Does Economics Offer? In *Rehabilitating Damaged Ecosystems*, J. Cairns (ed.), pp. 35-47. Lewis Publishers, Boca Raton, FL.
14. Smith, M. R., P. W. Mattocks, Jr., and K. M. Cassidy. 1997. Breeding Birds of Washington State. Volume 4 in *Washington State Gap Analysis – Final Report* (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich (eds.)). Seattle Audubon Society Publications in Zoology No. 1, Seattle, WA.
15. Thom, R. M. and K. F. Wellman. 1996. Planning Ecosystem Restoration Monitoring Programs. Evaluation of Environmental Investments Research Program, United States Army Corps of Engineers, IWR Report 96-R-23.
16. Thomas, J. W. (tech. ed.). 1979. Wildlife Habits in Managed Forests – the Blue Mountains of Oregon and Washington. United States Department of Agriculture Forest Service, Agricultural Handbook No. 553.
17. United States Department of Agriculture, Natural Resources Conservation Service. 2003. The PLANTS Database, Version 3.5 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
18. Washington State Department of Ecology. 1997. Washington State Wetlands Identification and Delineation Manual. Ecology Publication No. 96-94. WA.
19. Washington State Department of Transportation. 2002. Moses Lake Wetland Mitigation Bank Instrument. Environmental Affairs Office, Olympia, WA.
20. Washington State Noxious Weed Control Board. 2003. Washington State Noxious Weed List. www.nwcb.wa.gov. WA.
21. Whitson, T. D. (ed.). 2001. Weeds of the West. The Western Society of Weed Science. 9th edition. Grand Teton Lithography, Jackson WY.
22. Zar, J. H. 1999. Biostatistical Analysis, 4th edition. Prentice-Hall, Inc., Upper Saddle River, NJ.